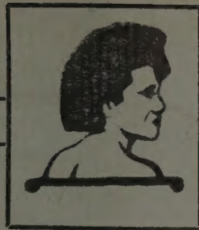
VOL. 28 NOS. 1 & 2

JUNE, 1957



COLONY OF FIJI

AGRICULTURAL JOURNAL

ISSUED BY THE

DEPARTMENT OF AGRICULTURE, FIJI

ANNUAL SUBSCRIPTION : SIX SHILLINGS

GOVERNMENT PRESS, SUVA, FIJI

AGRICULTURAL JOURNAL

So many requests are received for parts of the "Agricultural Journal" which were never published or which are now out of print, that the following list of all issues published is given for reference. Those volumes and numbers which are not now available are marked with an asterisk. It will be noted that copies of all parts of ten volumes and parts of nine other volumes are unobtainable. Should any reader have unwanted copies of these publications, the Librarian would be grateful to receive them.

Vol.				Vol.			
1.	3	numbers,	1928.	14.	4	numbers,	1943* (No. 3).
2.	4	,,	1929.	15.	4	,,	1944* (No. 2).
3.	3	,,	1930.*	16.	4	,,	1945.*
4.	4	,,	1931.	17.	4	,,	1946.*
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12.	4	,,	1941* (Nos. 1 and 2).	25.	4	,,	1954.* (Nos 1 and 2).
13.	4	,,	1942* (Nos. 1 and 2).	26.	3	,,	1955.
				27.	4	,,	1956.

AGRICULTURAL CIRCULAR, 1920-25

NUMBERS and year of issue of the "Agricultural Circular":—

Vol. 1, 1920,	12 numbers.	Vol. 4, 1923,	1 number.
2, 1921,	5 ,,	5, 1924-5,	2 numbers.
3, 1922,	4 ,,		

As number 4 of Vol. 3 was printed as "Volume 4" and number 1 of Vol. 4 as "Volume 5" it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume numbered as 5, No. 1.

ANNUAL BULLETINS, 1931-38

COPIES of Annual Bulletins of Divisional Reports for the year 1933 and 1934 ONLY are available.

AGRICULTURAL BULLETINS

A FEW copies of the following bulletins are available at the prices shown. Other Bulletins previously listed are out of print.

No. 1. Sisal Hemp in Fiji, by C. H. Knowles, 1911. Price 2s.
7. A Mission to Java for a Coleopterous Pest of Bananas, by Jepson, 1914. Price 2s. 6d
23. Insect Pests of Fiji, by R. J. A. W. Lever, 1946. Price 1s.
24. The Botanical Gardens, Suva, by J. W. Parham, 1948. Price 1s. 6d.
25. Copra Drying and Copra Driers, by W. J. Blackie, 1950. Price 1s. 6d.
26. Mechanisation of Rice Padi Cultivation by R. R. Mason. Price 2s. 6d.
27. Index to Agric. Journal. Vols. 1–21 by B. E. V. Parham. Price 2s.
28. Soil Erosion and its Control in Fiji, by C. E. Whitehead. Price 2s.
29. Annual Reports of Divisional and Specialist Officers 1954. Price 4s.
30. The Grasses of Fiji, by J. W. Parham. Price 5s.
31. The Declared Noxious Weeds of Fiji and their Control, by T. L. Mune and J. W. Parham. Price 2s.

AGRICULTURAL REPORTS

RECENT reports on Agricultural subjects are available as follows:—

Department of Agriculture Annual Report, 1953. C.P. No. 37, 1954. Price 5s. 6d.
Report by Sir Geoffrey Clay on his Visit to Fiji in 1954. C.P. No. 31, 1955. Price 1s. 6d.
The Fisheries Industries of Fiji. C.P. No. 1, 1956. Price 1s.
Department of Agriculture Annual Report for 1955. C.P. No. 8, 1956. Price 2s.
Department of Agriculture Annual Report for 1956. C.P. No. 8, 1957. Price 2s.

OTHER PUBLICATIONS

A FEW copies of the following important book are available:—

The Coconut Moth in Fiji, by J. D. Tothill, H. C. Taylor and R. W. Paine. Imperial Bureau of Entomology, 1930. Price £1.

FORTHCOMING PUBLICATION

THE following publication is in the press and will be available shortly:—

Book ... ... The Fishes of Fiji, by H. W. Fowler (approximately 600 pages and 200 illustrations).

Agricultural Journal

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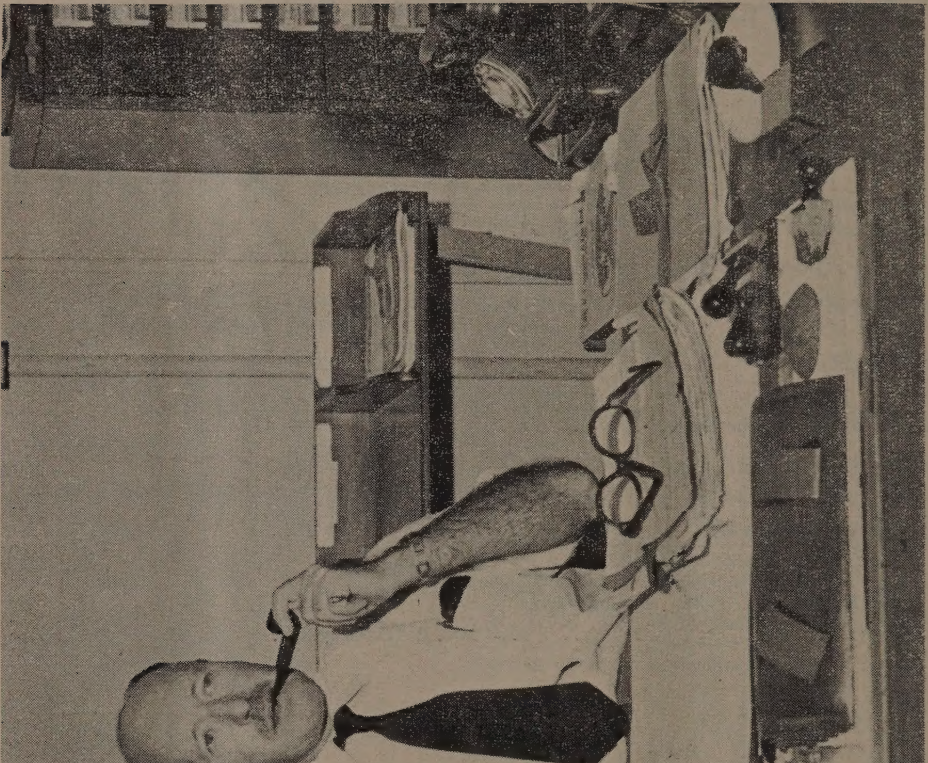


Mr. C. HARVEY, C.B.E.

After 30 years in the Colonial Agricultural Service, Mr. C. Harvey, Director of Agriculture, proceeded on retirement leave last April.

Mr. Harvey was for twelve years Agricultural Officer in Kenya and was appointed Senior Agricultural Officer in Fiji in 1939, when this post was, in effect, equivalent to that of Deputy Director. In 1945 he was appointed Director of Agriculture and became a member of Legislative Council.

Mr. Harvey has been primarily responsible for the evolution of the Fiji Department of Agriculture from what was originally a small inspection service with a few specialist and restricted activities, principally in the fields of entomology and chemistry, and has created the framework of advisory services based on research facilities, within which the Department is now developing along modern lines into an effective organization.

The benefits of his keen judgment and sound assessment of affairs have spread beyond his own department to the many permanent boards and innumerable *ad hoc* committees on which he has served during his time in Fiji: the Copra and Banana Boards, the Agricultural and the Education Advisory Councils, the Native Land Trust Board, the Central Board of Health and the Forestry Board have all had the benefit of his guidance and advice.

In 1950, his services to the Colony received Royal recognition when he was awarded the C.B.E., and in 1956 he was appointed a member of Executive Council. Although Mr. Harvey has now ceased to contribute actively to the development of the Colony, the influence of his wise counsel, at all times freely available and given in so typically modest and unassuming a manner, will always remain.

Cedric Harvey will long be remembered by all who knew him as a gentleman of the highest integrity and by his staff as a leader who inspired confidence, respect, loyalty and affection to an unusual degree.

EDITORIAL . . .

Of the many problems that confront the agriculturist in the wet tropics first and foremost is that of conserving the natural resources of the country and preserving its principal asset, the soil. Here in Fiji our sole asset is the soil and it is on the soil alone that we must depend for our wealth and our food, both now and in the future.

Yet, even now, our one and only asset is a declining one and there can be no let-up on the continued reiteration of the need for Soil Conservation in its fullest sense.

There are indications that we have at last penetrated the tough shell of indifference and that the lesson of Soil Conservation is beginning to sink in; but it is a slow process, far slower than the natural processes of erosion and ruination that take their daily toll of our agricultural soils.

We have made a start; the farmer has been awakened and alerted and in many instances individual farmers are now able to prove for themselves that their cane yields are better on contoured land, that their drains do not silt up and that the run-off water in them is far less muddy than the soil-carrying torrents that course unchecked through their neighbours' fields; but they are powerless to control the flooded rivers, to remove the silt-beds and obstructions that impede and swell the floods. Soil Conservation must begin in the watersheds, at the river sources and in the catchment basins, by preservation of the forest cover on the steep slopes and mountain ranges, by intelligent and controlled management of the lower slopes and already-denuded forest areas, by detailed study of the flood characteristics of the rivers and by facilitating the quick discharge of flood waters.

These are matters beyond the individual farmer or small farmers' groups; their contribution here must be by understanding of the problems and by each contributing his share towards the cost of major works. And the longer we delay the higher will be the cost, not to be reckoned in mere pounds but in generations of human struggle and despair.

New Agricultural Publication . . .

THE DECLARED NOXIOUS WEEDS OF FIJI AND THEIR CONTROL

BY T. L. MUNE AND J. W. PARHAM

A bulletin describing the declared noxious weeds of Fiji and their control has been published and is on sale at the Department of Agriculture. The bulletin contains descriptions of the fifteen declared weeds and gives full details of the most satisfactory method of control for each weed. There is also a section describing the methods of application of weedicides and a table giving the rates of application for each of the brands on sale in Fiji. An appendix describes Navua sedge which is becoming a serious weed of pastures in Fiji. There are 16 line drawings and 17 photographs. The cost is 2s. per copy. Orders may be sent to the Director of Agriculture, Suva.

AGRONOMY . . .

THE ALLUVIAL SOILS OF THE "WET" ZONE

BY I. T. TWYFORD

(Being a description of the deltaic alluvial series of soils as generally found in the "wet" zone of Fiji. The actual area which was surveyed was the flats of the Principal Agricultural Station, Koronivia; it was known from the reconnaissance soil survey of Fiji that these were typical of the Rewa and Navua deltas, and the Wainivesi flats.)

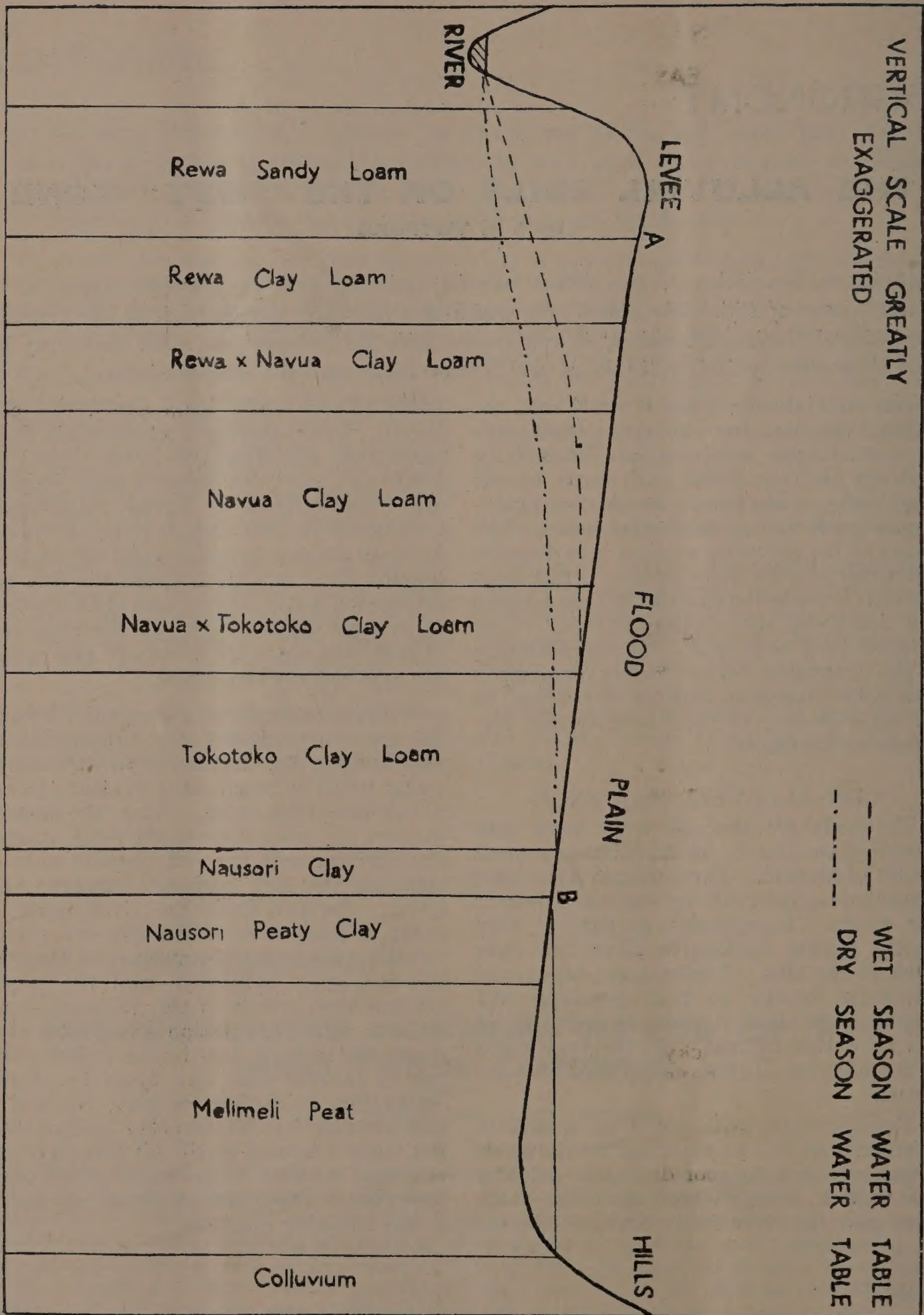
The alluvial soils of the "wet" zone are highly important from an agricultural point of view. They comprise our best dairy pastures and rice land, and much of our cane land. Some market gardens and pineapples are found on the sandier areas. The object of the following account is to describe the series of soils more or less in line from the river levee to the foothills, so that farmers can recognize the various members that exist on their own land. An interpretation of the differences between series members is also given, together with an indication, as far as is known, of their fertility and responses to fertilizers.

THE ALLUVIAL SEQUENCE

The soils are derived from basic and intermediate alluvia, with probably a small acidic admixture. These alluvia have been deposited at intervals by various floods of the rivers. Topography is flat or very gently sloping backwards from the river bank to the hills. Textures are heavy and structures blocky so that drainage over much of the area is poor, culminating in the formation of peat. At the very bases of the hills, small areas of colluvial soils are found.

The sequence, with soil type names in brackets, can best be described by the levels of the wet and dry season water tables in the various soils. Where these are both deep near the river freely drained soils are found (Rewa sandy loam and Rewa clay loam). As the surface level gradually drops back from the river the water table rises relatively, and a few signs of poor drainage are found (Rewa x Navua clay loam). Soon these become enough to make the soil a poorly drained one with a distinct mottled horizon (i.e. the zone between the wet and dry season water tables), and at the bottom of average depth profile pits the first signs of true gley, i.e. a grey, blue, or green clay, are seen (Navua clay loam).

With increasing poor drainage the mottled horizon comes nearer to the surface, and the gley horizon (i.e. that below the dry season water table) is much more evident (Navua x Tokotoko clay loam). Next, the mottled horizon, i.e. wet season water table, reaches the surface, and the soil consists only of this and the gley horizon (Tokotoko clay loam). Farther from the river again, a point is reached at which the dry season water table reaches the surface, so that the soil is always saturated, and the profile consists then merely of gley (Nausori clay). As soon as the dry season water table rises above the surface, peat begins to form, and this is divided into two types by depth. When this is shallow on gley, the soil is still considered as Nausori clay, peaty phase, but when a normal profile pit fails to reveal any clay above 18", the soil is called Melimeli peat. These considerations are shown in the following diagrams:—



Fig—Section across typical wet zone flood plain showing soil sequence and rise of water tables.

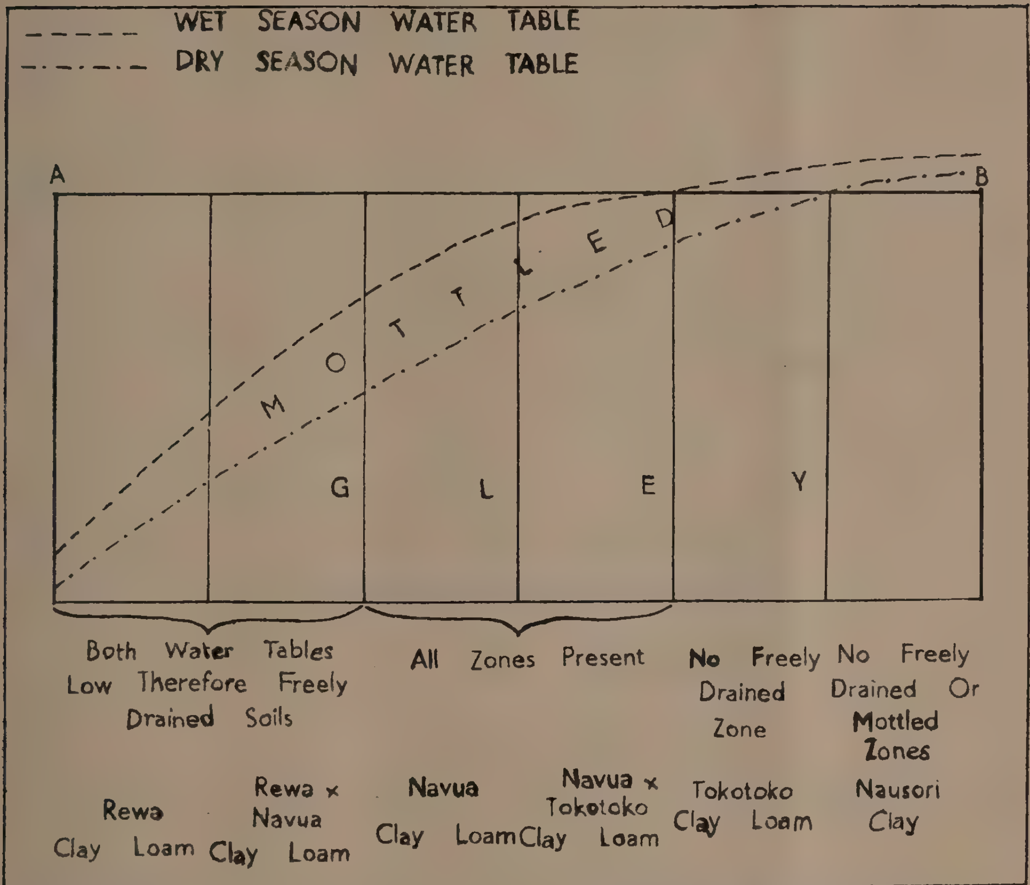


Fig. 2—Enlargement and stylization of section AB, fig. 1, showing freely drained zone above wet season water table, the mottled zone between the two tables, and the gleyed zone below the dry season water table.

In addition to the foregoing considerations mottling is often found in surface horizons of all soils less poorly drained than Tokotoko clay loam because of some surface impedance of drainage due to blocky structure, particularly where cattle have pugged the soil.

VEGETATION

The tolerance of some plants towards differing degrees of poor drainage shows up well on the alluvial sequence. The main members of the herbage associations present, with their frequency of occurrence are:—

PARA GRASS (*Brachiaria mutica*)—This grows well on all soil types from the river to Tokotoko clay loam, after which only very scattered examples are found.

SENSITIVE PLANT (*Mimosa pudica*) grow in association with para grass, and these two form the basis of the pastures of the alluvial flats. It is found very occasionally also on peat.

ROUGH GRASSES especially jungle rice and sour grass grow best on the more poorly drained members of the sequence, except peat.

LARGE SEDGES especially (*Rhynochospora corymbosa*) are not found in more freely drained members than Navua clay loam, then they increase to a maximum at the Nausori clay and peaty clay stages, dropping somewhat on the true Melimeli peats.

KUTA SEDGE (*Elæocharis articulata*) is not found until the complete gleying (Nausori clay) stage, and then increases and becomes maximal on peat, forming the main proportion of peat herbage.

MILE-A-MINUTE (*Mikania micrantha*) grows equally well at all stages of the drainage sequence, including peat. It is never a dominant member of the vegetational association however.

TARWEED (*Cuphea carthagenensis*) appears most frequently on the first members of the sequence, dropping away very sharply at the Tokotoko clay loam member to nothing beyond this soil.

ANHYDRA is found on the slightly poorly drained member, Rewa x Navua clay loam, and a little also is found both on Rewa and Tokotoko clay loams.

HIBISCUS BURR (*Urena lobata*) grows on moderately poorly drained Navua and Navua-Tokotoko clay loams, particularly the latter. It is not found in either drier or wetter areas.

YELLOW PRIMROSE (*Jussiæa suffruticosa*) is first found a little on the Navua clay loam, then much more frequently from the Navua-Tokotoko soil onwards, dropping somewhat only at the peat stage.

Desmodium heterophyllum suprisingly is found in the alluvial sequence only on peat in the case described, where it is very frequent although, of course, never the dominant member of the vegetational association.

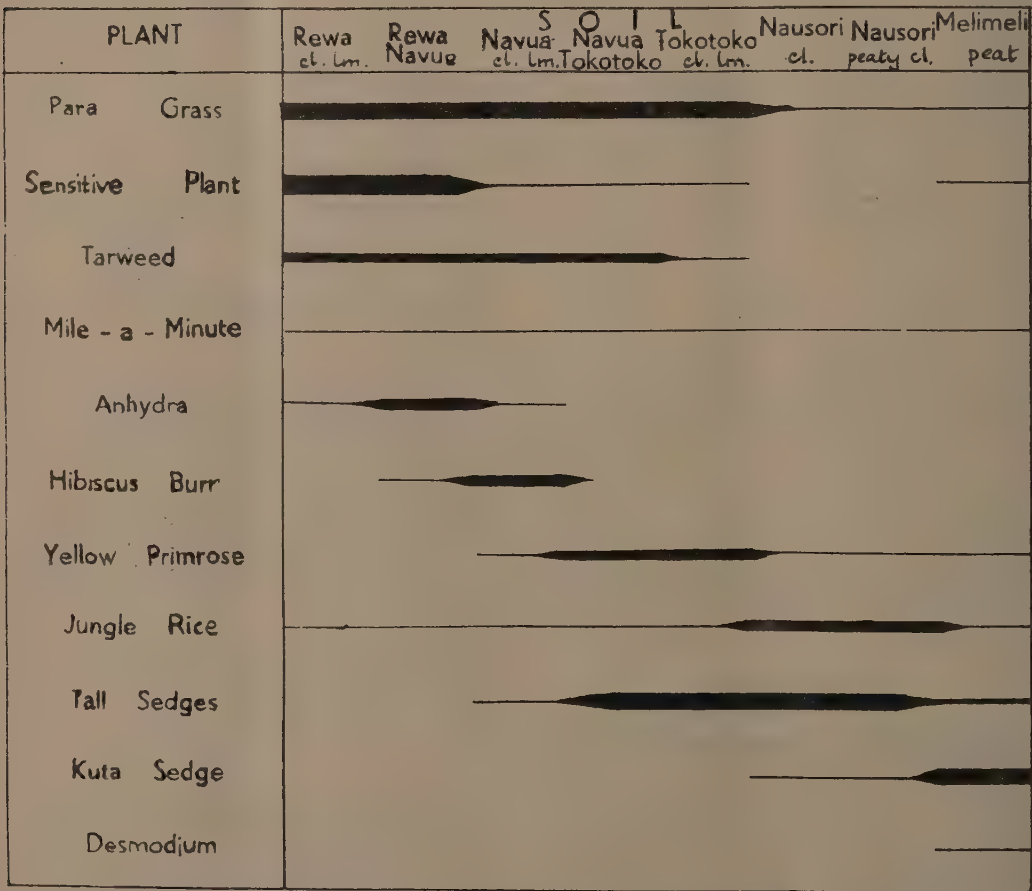


Fig. 3—Showing the relative abundance of plants on the alluvial sequence. The thickness of the line indicates the amount of each plant present in the vegetational association.

DESCRIPTIONS OF SEQUENCE MEMBERS

A—FREELY DRAINED

1. *Rewa sandy loam*—The soil occurs in a fairly narrow strip along the levee bank. It is never more than 120 yards wide. The main natural vegetation appears to be para grass. Profile characteristics are variable, and in all cases not very well developed, as would be expected for such a recent deposit. A profile well covered by para grass is:—

0″–1″ 7·5YR 3/2 dark brown loam, slightly sticky, weak fine blocky structure, containing many para grass roots, boundary distinct.

1″–7″ 7·5YR 3/2 dark brown fine sandy loam, firm to friable, moderate fine blocky structure, wormcasts granular, many para grass roots, boundary diffuse.

7″–27″ + 10YR 4/3 dark brown slightly mottled grey and very slightly yellow brown fine sandy loam, firm, weak coarse blocky structure, few roots.

Another profile with a deeper surface horizon under bananas is:—

0″–24″ 7·5YR 3/2 dark brown fine sandy clay loam, soft, friable, weak fine blocky structure, boundary diffuse.

24″–36″ + 10YR 4/3 dark brown fine sandy clay, firm, weak coarse blocky structure.

Variations between profiles are minor and consist of slight mottling in some cases but not in others, depth of surface horizon, textures, which vary from fine sandy loam to fine sandy clay loam in topsoils, or to fine sandy clay in subsoils.

The soil is easily workable and is a moderately fertile soil, though it responds to fertilizers N and P, at least with bananas. The pH of the soil type is about 6·5 so that it is not very leached and does not require lime. It is cropped mainly for bananas, tapioca, and market garden vegetables, and is also utilized as para grass, sensitive plant and centrosema pasture, all of which grow quite well without fertilizers. Under intensive cropping, it is probably trace element deficient. The main disadvantage of the soil is that it is liable to flooding.

2. *Rewa clay loam*—This type occurs immediately behind the fine sandy levee. It is freely drained, although surface mottling is occasionally found due to slow surface drainage, particularly after consolidation by trampling or machinery.

0″–9″ dark grey brown, very slightly mottled grey clay loam, firm, moderate coarse blocky structure, few roots, boundary diffuse (plough depth).

9″–20″ Dark grey brown mottled grey clay loam, firm to friable weak coarse blocky structure, aggregates glisten, boundary distinct.

20″–33″ + yellowish brown clay, slightly mottled grey and orange, firm, weak coarse blocky structure.

A profile with less mottling is:—

0″–10″ 10YR 4/3 brown to dark brown clay loam, firm, moderate medium blocky structure, boundary diffuse.

10″–20″ 10YR 4/4 dark yellowish brown clay loam with some faint grey mottling below 22 inches.

26″–30″ + 10YR 5/6 yellowish brown clay loam.

Variations through the soil type are only minor, textures varying slightly from clay loam to clay, amount of mottling small or none, topsoil varying in depth but nearly always quite deep.

The type is farmed intensively for tapioca, sugar cane, dry rice, and is also used as pasture. Yields are not high; the rice particularly looks very poor. It may be rated as moderately infertile. The pH is about 5·2. It responds markedly to dressings of superphosphate. This soil type and the previous one are very important because they comprise the only freely drained alluvial soils.

B—POORLY DRAINED

3. *Rewa* x *Navua clay loam*—This soil type occurs behind the Rewa clay loam in a thin band, and also is present in small depressions in the Rewa clay loam area. It is intermediate in drainage between the above member and Navua clay loam. The profile is different enough nevertheless, to

separate it on a detailed soil map. A profile under para grass-sensitive plant pasture is:—

0″–9″ brown clay loam mottled slightly with grey, firm to friable, weak medium blocky and moderate fine granular structure, containing many fine roots, boundary distinct.

9″–18″ yellowish brown moderately mottled grey clay, friable, weak coarse blocky structure, some roots, boundary distinct.

18″–30″ + olive grey mottled yellow clay, weak coarse blocky with some signs of columnar structure, few roots. Dry season water table at 28″.

The small area of this soil type (which would be called in U.K. a meadow soil) is mainly used for dairy pasture. Para grass and sensitive plant grow quite well on it, so that it may be classed as moderately fertile. Its pH is 5·6.

4. *Navua clay loam*—Navua clay loam is the most extensive deltaic alluvial soil and occurs in a strip behind the Rewa x Navua clay loam, and is more poorly drained. Both the dry season and wet season water tables are clearly visible in Navua clay loam profiles, so that all three zones of a poorly drained soil are present. In addition, the top unsaturated horizon is often slightly mottled near the surface due to pugging. A typical Navua clay loam profile is the following, covered by para grass, hibiscus burr, yellow primrose, and sedges:—

0″–6″ 10YR 4/4 dark yellowish brown, mottled grey and streaked red especially along the root runs, clay loam soft, sticky, weak fine blocky structure, very many roots, boundary distinct.

6″–17″ 5Y 4/1 dark grey mottled orange red along the many root runs, with increasing mottling of a paler yellow colour to the bottom of the horizon, clay, loam firm, slightly sticky, massive or very weak coarse blocky structure, many roots, boundary sharp.

17″–20″ + 5Y 4/1 dark grey clay, soft, very sticky, very weak fine blocky structure.

The three horizons above are respectively the zone of non-saturation, but mottled because of surface structure and pugging, the zone of intermittent saturation, and the zone of permanent saturation. Navua clay loam is another meadow soil and is used for pasture. It is suitable for development by drainage, or alternatively for wet rice production. Its pH is 5·5 and it is moderately fertile; para grass and sensitive plant grow fairly well on it. However, sedges invade the pastures. It responds well to coral sand, nitrogen and phosphorus fertilizers for good pasture production.

5. *Navua* x *Tokotoko clay loam*—The soil type occurs in a narrow band behind Navua clay loam. It is intermediate in drainage between Navua clay loam and Tokotoko clay loam, but more like the latter. Nevertheless it is sufficiently different to separate out in a detailed soil survey. In this soil the zone of non-saturation is very shallow but still present, unlike Tokotoko clay loam, and mottling in the zone of intermittent saturation is stronger than for Navua clay loam. A typical profile of this soil type under very poor pasture with many sedges and weeds is:—

0″–4″ 10YR 4/2 dark grey brown mottled grey and brownish red clay loam, firm, and sticky, weak fine blocky structure, many roots, boundary diffuse.

4″–21″ 2·5Y 4/0 dark grey grossly mottled yellow and orange clay, friable, moderate medium blocky structure, some roots, boundary distinct.

21″–30″ + dark 5Y 4/1 dark grey mottled dark greenish yellow clay, firm to friable, moderate coarse blocky structure, few roots.

Navua x Tokotoko clay loam is very acid (pH 5·1) and is infertile, growing only very poor pasture, with many weeds and sedges. It requires extensive drainage, nitrogen and phosphate fertilizers, if not potash. It may also be deficient in certain trace elements. Alternatively it can be used for wet rice growing, with nitrogen and phosphorus applications.

6. *Tokotoko clay loam*—Totokoto clay loam is the next most extensive alluvial soil after Navua clay loam. It is more poorly

drained than the previous soils, the wet season water table being more or less at surface level. Thus only two zones are present, those of intermittent and permanent saturation. However, at depth there are sometimes signs of entry of air, possibly by lateral drainage. A profile of the normal type developed under para grass and weeds is:—

0″–2″ 2·5Y 4/2 dark grey brown clay, slightly peaty, soft and sticky, very many fibrous roots, boundary distinct.

2″–12″ 5Y 4/1 dark grey clay with much coarse red mottling, soft and sticky, weak medium blocky structure, many roots, boundary diffuse.

12″–20″ + 2·5Y 4/0 dark grey mottled faintly yellow and green, clay, firm sticky, some roots.

The above profile has a slight peaty topsoil above the normal two zones.

A profile showing air in lower horizons, developed under rough grasses, sedges, and yellow primrose is:—

0″–3″ 10YR 4/2 dark grey brown mottled grey and orange peaty clay, soft and sticky, fibrous in structure, very many roots, boundary distinct.

4″–15″ 5Y 4/1 dark grey clay, slightly firm, sticky, very weak coarse blocky structure, many roots, boundary sharp.

15″–28″ + 2·5Y 6/0 light grey grossly mottled yellow and orange clay, soft, sticky, weak very fine blocky structure, few roots.

It is occasionally sandy in some areas.

Tokotoko clay loam is extremely acid (pH 4·3) and very infertile. It responds well to phosphate, nitrogen, and possibly trace element fertilizers. Drainage of the soil type would render it more useful for pasture, and a controlled water table would be essential for good crops of wet rice. In a word, Tokotoko clay loam naturally is a very poor, ill drained soil, but it should be possible to modify it to such an extent as to make it a very useful soil type.

In some areas, drainage of the soil type has been effected. One area was treated some time ago and now consists of shallow drains and cambered beds. The soil has drained to the extent that it might now be classed as Navua clay loam, a profile being—

0″–16″ 10YR 4/2 dark grey brown clay, faintly mottled grey and orange, boundary diffuse.

16″–23″ 2·5Y 4/2 dark grey brown clay grossly mottled grey and faintly orange, boundary distinct.

23″–36″ + 10YR 5/8 yellowish brown clay faintly mottled grey and orange.

Another area was drained very recently, by a system of deep drains and cambered beds, and the soil appears to be aerating well. Three inches of topsoil now exist which are only faintly mottled and the dry season water table has dropped about 6″. There appears no reason why this land should not make excellent pasture or even arable land, so long as drainage is looked after. The soil needs applications of phosphate, nitrogen and possibly potash, however, for maximum production.

7. *Nausori clay*—This is the ultimate poorly drained mineral soil. It consists only of a permanently saturated zone, (although this may be two horizons), i.e. the dry season water table is at the surface. Nevertheless water does not lie on the surface deep enough to induce true peat formation. Nausori clay is a true gley. A profile of Nausori clay under sedges and weeds is:—

0″–4″ 10YR 4/2 dark grey brown mottled grey slightly peaty clay, soft, sticky, very many roots, boundary distinct.

4″–15″ + 2·5Y 5/0 grey clay very slightly mottled red, friable, very weak coarse blocky structure, horizon contains some very fine hard clay granules.

Another more colourful one is:—

0″–6″ slightly bluer than 5Y 4/1 dark grey clay, slightly peaty, soft and very sticky, very many roots, boundary distinct.

6″–18″ + pale blue mottled 5Y 5/6 olive yellow clay, soft and very sticky, some roots.

Nausori clay is very acid and lies behind Tokotoko clay loam in the sequence. It is hard to judge the fertility since the drainage is zero, but it is probably low. It would respond to drainage, nitrogen and phosphate at least.

8. *Nausori peaty clay*—Nausori peaty clay lies in a thin strip farther back from the river than Nausori clay, and is formed under the same conditions except that the dry season water table is a little higher than the surface and a shallow layer of clayey peat or peaty clay has a chance to form. It is not a very important soil type. A profile developed under sedges and weeds is:—

0″–10″ dark grey brown peaty clay
10″–30″ + dark grey clay, highly gleyed.

9. *Melimeli peat and soft peat*—This is the ultimate poorly drained soil, and consists almost entirely of organic matter, whose decomposition has been arrested by anærobic conditions. Melimeli peat may be divided for convenience into two groups, that in which the organic matter is tough, fibrous, and matted, and that in which it is soft, where presumably decomposition has progressed a little further. The latter peat is designated as " Melimeli soft peat ".

Melimeli peat consists mostly of slightly decomposed sedges which retain their living appearance to a great extent, and also a soft jelly-like substance which may be a further decomposition product.

A typical profile under sedges, especially *elæocharis articulata* is:—

0″–8″ brown tough fibrous peat, boundary diffuse.
8″–16″ grey brown peat with a little clay.
16″–24″ + dark grey very peaty clay.

The above is near the edge of the peat area. Farther in, the peat gets deeper before reaching clay. A profile of this type in which decomposed fern has formed a thin surface layer is:—

0″–2″ very dark brown soft pseudofibrous peat.
2″–64″ brown fibrous peat.
64″–78″ + grey clay.

The deepest peat recorded is 80″ which was the maximum depth of convenient observation. However, it is certain that the peat is deeper than this in places, though probably no deeper anywhere than ten feet.

Melimeli soft peat is similar to the above in all respects even to variations found, but it occurs only in the middle of peat areas, and the fibres of plant material which form it are not tough but soft. The main effect of this is that it is very difficult to walk on it.

The pH of the peat and peaty water varies between 4·0 and 5·7, on the average about 4·5.

Melimeli peat covers the alluvial area between the swamp soils and the hill colluvia. It projects in long narrow tongues up the numerous valleys of the foothills.

It is difficult to judge the fertility of peat. A pot experiment with drained peat grew good tomatoes after heavy addition of lime and phosphate, but nitrogen gave no response. If it could be drained, it should be possible to modify it by fertilizers enough to convert it to a good soil suitable for growing vegetables or possibly pineapples, as is the case in Malaya.

However, peat soils are not easy to modify; nutrient balance is easily upset on these soils, particularly for trace elements such as manganese. It would certainly require considerable experimentation.

SUMMARY OF ALLUVIAL SOILS

Name	Wet Season Water Table	Dry Season Water Table	Approximate Proportion of Area
			Per Cent
Rewa sandy loam	Deep	Very deep	1
Rewa clay loam	Deep	Very deep	2½
Rewa-Navua clay loam	Moderately deep	Deep	2
Navua clay loam	Moderately shallow	Moderately deep	51
Navua-Tokotoko clay loam	Shallow	Moderately shallow	3
Tokotoko clay loam	At surface	Shallow	35
Nausori clay	Above surface	At surface	½
Nausori peaty clay	Above surface	Above surface	
Melimeli peat	Above surface	Above surface	5
Melimeli soft peat	Above surface	Above surface	
		Total	100

THE DRAINAGE OF THE ALLUVIAL SOILS

Some of the soils of the alluvial sequence are described above as poorly drained at the surface as well as at the water table. When draining such soils as Rewa, Navua, Navua x Tokotoko and Tokotoko clay loams, it should be remembered that ditches do not provide a complete answer. The function of an open drain is to lower the water table. Insofar as the poor drainage is caused by a high water table, therefore, ditches are effective. However, poor drainage derived from topsoil pugging or structure is a different situation. The structure of all the alluvial soils is blocky, and such soils when wet swell up, the peds (or aggregates) close together, and drainage is thereby impeded. This phenomenon is, of course, most noticeable at the surface. Water remains on top and much of it evaporates away rather than drains away. Furthermore, a blocky structure hinders the lowering of the water table, since water cannot easily soak out. Thus ditches only give slow drainage. On the other hand once the soil is drained, it will not easily again become completely waterlogged, because impedance of water entry will take place at the surface, thereby leaving lower horizons still freely drained.

However, it is not desired in normal farming practice to have this surface impedance unless for wet rice growing, usually pasture plants grow best in a moist but not wet soil. It appears therefore to be necessary to cultivate the topsoil regularly in order to break up clods formed of aggregated blocky peds to permit entry of water. Further, a good level of organic matter should be kept up, since this has the effect of cultivation (but on a much more thorough basis), of loosening soil blocks.

It may even be worth while trying soil conditioners such as "Krilium" also to try to improve surface drainage.

Drainage of the alluvial soils is the key to their succesful use. Only when drained is it worth attempting to work out, for example, fertilizer requirements.

NOTE ON BURIED TOPSOILS

Signs of buried topsoils are evident on the alluvial flats here and there. The depth of the top of the buried topsoils varies often between 25 and 30 inches, and the horizontal depth is about 10 inches. Presumably it was caused by the succession of floods from the river; such features are often found in alluvial soils. The significance is that at some stage when this horizon was at the surface, there must have been quite a long period before the next flood, in order for topsoil characteristics to develop. Such a period must have been extraordinarily dry.

Its appearance is very much as the clay lying above and below it, but it is stained black, probably with manganese dioxide, and replaced root remains are clearly visible in some places.

CONCLUSION

The wet zone alluvial soils agriculturally are of the greatest importance to the Colony because of their ease of access and topography. The percentage areas of the various members however, show their main disadvantage in this climatic zone to be poor drainage. This can be rectified as pointed out in the section on drainage, subject to the proviso that enough fall can be obtained for drainage ditches. In most areas this is the case, but in a few areas, there would be difficulty in securing it and pumps might have to be installed. Tide gates may also be necessary. However, often such land could better grow wet rice, for which completely free drainage is not so important.

With regard to the fertility of the soils, it is felt that they cannot as they stand be regarded as anything but potentially fertile. It is true that they grow fair crops, particularly at first, but continued usage, coupled with the heavy rainfall of their climatic zone soon impoverishes them, and crops become poor.

Departmental field and pot trials have shown the importance of the use of superphosphate particularly, and sulphate of ammonia or urea, and coral sand, though no response to lime has yet been found. It is possible that the beneficial effect of coral sand is due to factors other than its lime content, though these have not yet been investigated.

The whole picture of the nutrient dificiencies on these soils is not known, but by regular use of superphosphate, urea and

coral sand, it should be possible greatly to increase production. Recommendations differ for different crops of course; for pasture, about 3 tons coral sand per acre every two or three years, 3-4 cwt. superphosphate per acre per year, and $\frac{3}{4}$–1 cwt. urea per acre twice a year should give good results. For rice, somewhat lower rates can be recommended, and with only one application of urea per year. Market gardening is a much more intensive form of farming and it is certain that higher doses than those for pasture are necessary. Much work has still to be done on this, but it seems likely that potash and trace elements are required regularly.

ENTOMOLOGY . . .

NOTES ON THE CONTROL OF ORYCTES RHINOCEROS L. BY THE USE OF INSECTICIDES

BY B. A. O'CONNOR

4400

In previous articles in this Journal, ([1], [2]) some account has been given of the use of insecticides against the Rhinoceros Beetle. These notes describe modifications and improvements in the methods used, and mention results obtained with trials of various insecticides and formulations:—

CROWN TREATMENTS

The standard mixture used for treatment of the crowns of coconut palms remains the same, namely one part by volume of B.H C. 50% dispersible powder (6·5% gamma isomer) in nine parts by volume of damp sawdust. This is placed in the axils of the youngest four or five fronds, all climbers being provided with climbing-irons worn over boots. At the base of each frond a

Plate 1—Funnel and Climbing-irons

pocket is formed by a sheet of fibrous material known locally as the "vulo". Experience showed that this sheet was often torn when a climber forced the young frond outwards in order to make a space for applying the B.H.C.-sawdust mixture. In such cases, only a small quantity of mixture remained in the axils of the fronds. Moreover, the climber was in an awkward position when he was pulling a frond outwards with one hand and applying mixture with the other, and a good deal of the mixture was wasted.

In order to make the task of application simpler and less ardous, to allow the climber to use both hands, to avoid wastage of material and to prevent tearing of the "vulo" a simple funnel was devised. This is made of sheet steel, and is rectangular in cross-section, six inches long, three inches by two inches at one end and $1\frac{1}{2}$ inches by one inch at the other. The climber pulls a frond outwards just far enough to insert the funnel in the axil, narrow end downwards, works the funnel into a suitable position, places the B.H.C.-sawdust mixture in the funnel. and tamps it down with a short stick. Climbers have been provided with these funnels since February, 1956.

Laboratory and cage tests have been made with a range of insecticidal formulations. The standard test is to place a number of beetles in a mixture of insecticide and sawdust for two hours, then remove them to clean sawdust, with sugarcane as food, and observe results. For tests of residual effect, the mixtures are put into wire-gauze cages and placed in the open for various periods, then brought into the laboratory and tested again. Length of exposure of the beetles after the mixture has been in the open is usually three or four hours. It has been found that emulsions or emulsifiable concentrates of a given insecticide produce a much quicker knockdown of beetles than do wettable powders. B.H.C. in these formulations, when mixed with sawdust, has also a very good residual effect. However the mixing of these formulations in bulk quantities of sawdust, when the job is being done by unskilled personnel, could be a problem. (The mixing of wettable powders with sawdust is simple, as the white powder shows up well in the mixture). There is some indication also that B.H.C. miscible concentrate mixtures may have a repellent effect on the beetle, whereas B.H.C. wettable powder mixtures do not.

Mixtures are always made on a basis of volume, a method suited to use by untrained workers. The objective in our laboratory tests has been to use insecticidal mixtures which cost the same. This has not always been possible, owing to lack of information regarding prices. In these tests the volume of damp sawdust and of insecticidal powders has been based on loose, uncompacted materials.

Results of a series of laboratory tests are presented in the table below. Results from controls of untreated sawdust are not given, as mortality rarely occurred in these.

The results achieved by Diazinon wettable powder are remarkably good. The mixture produced a quicker knockdown and a better residual effect than our standard mixture of one part by volume of B.H.C. 50% wettable powder in nine parts of damp sawdust. It will be tested in the axils of palms placed in a large cage with beetles, and observations will be made as to whether it has any repellent effect. Previous tests in the cage have indicated that mixtures of B.H.C. 50% wettable powder and sawdust do not repel beetles, and may even have some attraction for them, but that mixtures containing B.H.C. miscible concentrate may have repelled the beetles.

TREATMENT OF SAWDUST ACCUMULATIONS

Sawdust heaps at timber mills are important breeding-places for *Oryctes*, and are difficult to cope with. Disposal of the sawdust in water-courses or by burning is possible at certain mills, and sawdust heaps at other mills are regularly searched and treated with B.H.C. However, in spite of these measures, considerable breeding has occurred. In February, 1956, we began to supply sawmillers with B.H.C. 50% wettable powder, so that they could treat the fresh sawdust as it is wheeled away from the bench in a wheelbarrow. The standard rate of treatment is 6 ounces of the wettable powder to 10 cubic feet of sawdust. Each

Insecticidal Formulation	Volumes of damp sawdust mixed with one volume of formulation	Weight in grammes of active ingredient in 2400 cc. of damp mixture	Period of exposure of mixture to weathering	Length of time beetles kept in mixture	Number of test beetles used		Results
					Male	Female	
			Days	Hours			
Malathion 50% Emulsifiable Concentrate	240	5	....	2	5	5	After 24 hours, nine dead or moribund, one male immobilized
Malathion 50% Emulsifiable Concentrate	240	5	10	3	4	2	No mortality after 3 days
Malathion 25% Wettable Powder	32	10	....	2	4	2	Five beetles dead or moribund after two days. One female alive after 6 days
Diazinon 16% Emulsifiable Concentrate	96	4	....	2	5	5	All immobilized after the 2 hours' exposure. All dead or moribund within 24 hours
Diazinon 16% Emulsifiable Concentrate	96	4	9	3	4	2	All dead or moribund within 2 days
Diazinon 16% Emulsifiable Concentrate	96	4	30	3½	4	2	All unaffected after 3 days
Diazinon 32% Wettable Powder	16*	10*	....	2	4	2	All dead or moribund after 18 hours
Diazinon 32% Wettable Powder	16*	10*	28	3½	5	5	All dead or moribund within two days
Diazinon 32% Wettable Powder	16*	10*	156	4	3	7	All dead or moribund after 4 days. (Nine after 2 days)
Aldrin 40% Emulsifiable Concentrate	72	14	....	2	4	2	All dead or moribund after 2 days
Aldrin 40% Emulsifiable Concentrate	72	14	34	3½	6	4	After six days, only one female dead, four males and one female immobilized
B.H.C. Emulsion (6·5% Gamma isomer)	16	10†	....	2	6	4	After two hours' exposure, eight immobilized. All moribund after 18 hours
B.H.C. Emulsion (6·5% Gamma isomer)	16	10†	15	3	12	8	After 3 hours' exposure, all immobilized. All dead or moribund after 2 days
B.H.C. Emulsion (6·5% Gamma isomer)	16	10†	160	4	4	6	After 24 hours, and also after 4 days, 3 males and four females dead
B.H.C. Miscible Concentrate (20% gamma isomer)	60	9†	....	2	12	8	All immobilized after 2 hours' exposure. All dead or moribund after two days
B.H.C. Miscible Concentrate (20% gamma isomer)	60	9†	37	4½	7	5	After three days, two male, one female dead, one male, one female immobilized. After seven days, 6 male, one female dead or moribund
B.H.C. Miscible Concentrate (20% gamma isomer)	60	9†	145	4	3	7	After four days, three males, 4 females dead or moribund

* It is now known that this mixture would cost three times as much as the standard mixture of B.H.C. wettable powder and sawdust.
† Gamma Isomer.

mill is supplied with a container of the size adapted to the cubic content of the wheelbarrow in use, this container being used to measure the appropriate quantity of B.H.C. Since this system began, there has been a heavy fall in breeding found in sawdust, and it is hoped that this state of affairs will continue. On one occasion a mill was inspected while the saws were out of action, and a large number of beetles and grubs was found immediately under the saw benches. Consequently millers are now instructed to apply B.H.C. to sawdust in this situation also.

LITERATURE CITED

[1] O'Connor, B. A.—"The Rhinoceros Beetle (Oryctes rhinoceros L.) in Fiji"—Fiji Agric. Journal. Vol. 24, Nos. 1 and 2, pp. 35-46, 1953

[2] O'Connor, B. A. "The Rhinoceros Beetle (Oryctes rhinoceros L.) Notes on the control campaign in Fiji"—Fiji Agric. Journal. Vol 25, Nos. 3 and 4, pp. 84-88, 1954.

Plate 2.—Climbing-irons in use

SOIL CONSERVATION . . .

FLOOD MITIGATION AND CONTROL

(TEXT OF A SOIL CONSERVATION CIRCULAR BASED ON A BROADCAST TALK)

BY C. E. WHITEHEAD

We are apt to dismiss with a complacent shrug of the shoulders the annual advent of minor floods in our rivers and streams, and it is not until the forces of Nature go on the rampage and great walls of water tear down across productive farm land and through our towns, that we are jolted into appreciating the urgent need for doing the best we know how to control floods. The flood catastrophe in the west and north-west areas of Viti Levu and in Vanua Levu during 1956 should be a grim enough reminder of this need for positive and concerted action. If we were to list the damage done in these areas, the sum total would reach staggering proportions. And yet, if one spreads the enormous damage caused by this one great flood over all the years between such events, the average annual loss is considerably less than the damage from all the smaller local floods that occur, year after year, in the smaller watersheds.

We have no justification, therefore, for feeling that we cannot afford expenditure on flood control in these times of minor floodings or that nothing can be done to prevent the occurrence of what is mistakenly considered to be a caprice of nature beyond our influence. Rather, we should recognize a flood for what it is—a warning that in producing great agricultural wealth from the land on the one hand, we have done so at the cost of tree-cleared hills and watersheds, soil-eroded farm lands, fire- and stock-depleted range lands, and heavily silted rivers on the other.

It is possible to eliminate almost completely the smaller and more localized floods, and it is practicable also to greatly reduce the damage caused by a super flood similar to the one from which we have not over long recovered. The degree of success we achieve in this direction will largely depend on our determination, and the effort we put into the battle against floods.

The important problem confronting us, then, is to determine, in co-operation with each other, what damage has already been done and how best to repair it, and what kinds and combinations of measures are needed, watershed by watershed, to accomplish the most effective flood control. No single method of control or individual effort will be effective. We must devise a sound plan for a whole watershed and develop it in its entirety.

Our job, then, is (1) to introduce legislation which will enable us to organize ourselves into well-ordered bodies recognized by the law, and empowered by law to do all things within defined watershed areas, which are considered necessary to prevent or reduce flood damage; such legislation would be in the nature of an ordinance authorizing the formation of local Catchment Boards, each empowered to develop an approved plan of flood control in any entire watershed area by the use of funds derived from subscribed loans, subsidy, and levies made on the community living within the area. The latter would be on a sliding scale with those members of the community deriving the greatest benefit from work performed by the Board, contributing the greatest amount; (2) to appoint to membership of Catchment Boards a truly representative cross section of the communities of

watershed areas: thus a typical Board would comprise representatives of farming settlements or organizations, local municipal authorities, administration, and technical officers dedicated to the preservation and development of natural resources, and a prominent citizen. The Board should be able to call on the services of a trained and qualified engineer to assist with the evolution of a plan which is technically sound in its treatment of engineering problems, such as main river channel way and bank stabilization, retention dam location and construction, and other works related to hydraulic engineering which have a place in the plan; (3) where possible, to assess and repair damage already done within the main waterways. There is no use in devising a plan for development in a watershed if damage which has already been done, and which contributes to flooding, is neglected. This is the first step in the rehabilitation of a watershed, and although some of it will be of such magnitude as to comprise an engineering work to be encompassed by an overall plan, much can be done without ceremony, Board or no Board, to retrieve our rivers from the highly dangerous state into which they have deteriorated. An example of this work is the river clean-up programme in progress in the Nadi river. Farmers have done much to help themselves against possible flood damage during the forthcoming wet season by removing from the river-bed and along its banks, innumerable trees, logs and debris clusters. This work may possibly tip the scales against a disastrous build-up of water held back by the imponderable masses of sand bars and shingle bed which repose in the lower section of the Nadi river-bed. It is work that could be well repeated by farming communities along the lower sections of every river in Fiji; (4) to devise and put into operation an overall plan of control; in no event will watershed planning and treatment be accomplished overnight by some magic formula, although it takes heavy rain and excessive run-off only a few days to do irreparable damage to watershed land and property.

Our plan of operation will necessarily be a long term one, involving:—

(*a*) downstream engineering. We have for so long failed to appreciate the ominous siltation of our rivers and erosion of their banks, that we are to-day faced with large scale clearing operations involving the dredging of river mouths and deltas, realignment of channel ways through innumerable walls of shingle and sand, and the groyning of sections of river banks where deflected currents have savagely ripped into our richest farm lands. In various places we will be working in a race against time to prevent the water-table of the coastal flats rising to transform rich land into a non-productive quagmire;

(*b*) land treatment. The hotchpotch manner in which the land of many of our watersheds is used for agricultural and pastoral pursuits must be replaced by a plan of use based on the capabilities of the land, using each acre for the purpose to which it is best suited. This means producing wealth from it without encompassing its destruction in the process. Here again, we can but advance slowly, but until we have only the rich, gently sloping land devoted to crop production, the grass lands of the foothills to controlled stocking, and the broken, steep mountain area covered in forest, we cannot hope to achieve any worthwhile control of floods;

(*c*) agricultural practice. Our efforts to control floods must begin where the rain strikes the ground. Every additional gallon of water that we can get into the soil, by improving its intake capacity with good farming practice combined with soil conserving measures, means one gallon less contributed to the flood flow and one pound less of silt in the river course to obstruct it. If, in any watershed, we can so treat the area that a large percentage of the rain which falls is retained in the soil, and the run-off so slowed down and delayed that the waterways do not become overloaded, we will have achieved our goal, or, if the waterways have not as yet been channelled, prevented flood waters from reaching disastrous proportions. To achieve this, we must:

(i) in our crop lands of the lower regions, maintain the soil in a rich porous condition by combining good farming practice such as crop rotation, manuring and cover-cropping, with such conservation measures as contour ploughing and cropping, terracing, bunding, and grass waterway establishment;

(ii) on our range lands of the foothills, manage stock under a controlled system of rotational grazing to ensure that pastures which we have improved are not so depleted as to leave the ground bare;

(iii) on our mountains and hills of the upper watershed, farm our forests under a carefully considered plan of use and replenish worked-over areas with adequate replantings.

In addition to all this, we must, at all costs, call a halt to the criminal practice of illegal stocking, timber cutting and firing of the range lands of the foothills. It can definitely be stated here that irresponsible firing of our range lands is the largest contributing factor to soil erosion which we have in the Colony.

(*d*) up-stream engineering. In this work, we need skill of the highest engineering order in determining, for the watershed plan, densities and frequency of precipitations in various sections of the river, total flood load under various conditions, and so on. On this assessment will depend whether retaining structures are to be built or not, and if to be built, where to be located and at what cost; whether the cost is justified as against the cost of damage which would have been sustained in the areas which they will protect from flood spread; the frequency over the years they would serve their purpose of preventing this flood spread.

Watershed engineering all rests, in the first place, on hydrological data which must necessarily take years of recording to accumulate.

Thus, at the finish, we shall have devised and developed an overall plan, securing our watersheds and waterways; and we will no longer, in fearful anticipation, await a swirling wall of destruction to descend upon us.

While doing this, we will have received help and guidance from a concerned and sympathetic Land Conservation Board. Quite possibly we will have been greatly assisted by the loan of necessary heavy machinery from a co-operative Catchment Board machinery pool.

In the meantime, however, we can be sure that, quite apart from the annual occurrence of minor floods, we have yet to contend with many a peak flood striking from any quarter of the compass. Let us then dispense both with the anguished cries of the stricken and the complacent shrugs of the disinterested, and unite in:

forming ourselves into organized bodies, as authorized Catchment Boards with powers to finance our works;

assessing and repairing flood damage already done; devising and putting into operation overall plans for watershed protection and flood control embracing:—downstream engineering; land treatment; sound agricultural and conservation practice on crop lands; controlled rotational stocking of our range lands; planned forestry management in the upper watershed regions; watershed engineering; and co-operative interchange of advice and assistance between kindred Catchment Boards.

NUTRITION . . .

FISH FLAKES FROM THE SOLOMON ISLANDS

BY F. E. PETERS AND PAMELA A. WILLS*

A method of fish preservation, which has been demonstrated in the British Solomon Islands Protectorate, has been outlined by Mr. H. van Pel, Fisheries Officer of the South Pacific Commission. This method consists of cleaning the fish and boiling them for 30 minutes in a mixture of 3 parts of sea water and 1 part of coconut water. After cooking, the bones are removed and the flesh is broken into small pieces which are slowly dried for 24 hours over a small fire. The final product consists of yellow-brown flakes ¼ to ½ inch long which have a pleasant though slightly smoky taste.

The fish product is relatively simple to make and keeps well. It could be used as an item of trade between coastal peoples and the inhabitants of the interior of the larger islands of the South Pacific. The diet of most inland peoples in these islands is based on starchy foods and is deficient in animal protein. These fish flakes could provide this type of protein at a cost which would be lower than imported tinned fish which is now widely used. The salt content would also be advantageous to inland peoples who often have little or no salt available.

A sample of the fish flakes sent to this laboratory was found to have the composition shown in Table I.

TABLE I

COMPOSITION OF FISH FLAKES

	%
Water	7·0
Ether extract	7·0
Total nitrogen	9·0
Crude protein	56·3
Ash	10·0
Calcium	0·20
Phosphorus	0·25
Chloride (as NaCl)	2·25

We wish to thank Mr. H. van Pel for supplying us with a sample of fish flakes for analysis.

* Biochemist and Assistant, respectively, South Pacific Commission, Noumea, New Caledonia.

WEED CONTROL . . .

ELLINGTON CURSE AND ITS CONTROL IN FIJI

BY T. L. MUNE AND J. W. PARHAM

A much branched, woody shrub, eight to twelve feet high with bipinnate, green leaves consisting of many leaflets. The light coloured stems are armed with large thorns and the flowers are globular, yellow and fragrant. The fruit (pods), which are borne in clusters, are green turning to dark brown at maturity, two to three inches long, and each containing twelve to fourteen seeds.

BOTANICAL DESCRIPTION

Acacia farnesiana Willd.
Family: Mimosaceae
(*Mimosa acicularis* Poir.)
Common Names: ELLINGTON CURSE:

VAIVAIVAKAVOTONA (F); BAN BABURI (H).

Perennial. Shrub, large, much branched, 8 to 12 feet (2·4 to 3·6 m) high, glabrous or slightly pubescent on petioles and peduncles. Leaves compound, pinnæ 4 to 6, rarely more, in pairs; leaflets 10 to 20 pairs, linear, about ½ inch (12 mm) long. Stipules in form of straight, slender thorns, ¼ to ¾ inch (6 to 18 mm) long. Peduncles, 2 or 3 together, each with a head of yellow flowers; bracts small; calyx about half length of corolla. Fruit a pod, thick, irregularly cylindrical, 2 to 3 inches (5 to 7·5 cm) long, indehiscent; seeds 12 to 14, lying in pith-like material.

SIGNIFICANCE

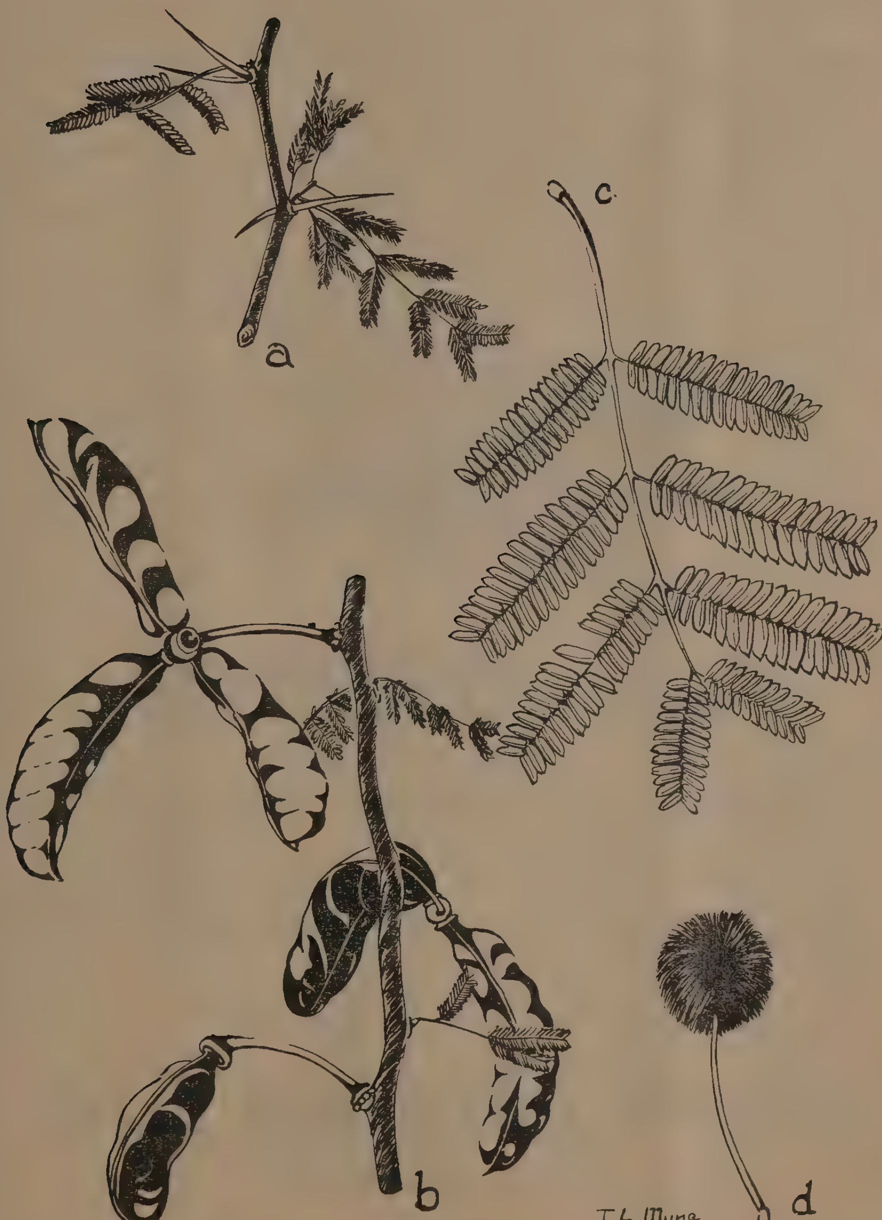
Widespread in the Ra and Ba Provinces of Viti Levu and known to occur in the Labasa district of Vanua Levu and on the island of Wakaya. It is a vigorous and aggressive plant which has laid waste to many thousands of acres of pastoral land.

CONTROL

Small infestations and scattered shrubs can be controlled by uprooting but care must be taken to destroy all the roots. As an alternative the shrubs may be cut at ground level and the cut stumps painted with three point six (3·6) pounds of acid equivalent of 2,4,5-T ester, diluted in thirty gallons of diesel fuel oil; this prevents any regrowth. This quantity (30 gallons) is sufficient to treat approximately five thousand stumps or one acre. The chopping down of shrubs without the use of herbicides is a futile waste of time and money.

In dealing with extensive infestations it has been found more economical to kill all young plants, up to two feet high, by spraying with three point six (3·6) pounds of acid equivalent of 2,4,5-T ester diluted in eighty gallons of water applied directly on the young plants without any pretreatment, using sufficient spray to thoroughly wet all leaves and stems and to basal treat all large shrubs with three point six (3·6) pounds of 2,4,5-T ester diluted in thirty gallons of diesel fuel oil. The herbicide is applied as a fine spray or painted on with a brush to the bark at the base of the stem, from two feet above ground level to ground level. It is important that all the bark in this area and any exposed roots are covered with sufficient of the mixture to wet them thoroughly without an excessive run-off.

Shrubs treated in this manner take from three to six months to die but defoliation is fairly rapid and as soon as this is complete a useful grass should be planted in the bare earth beneath the dying trees and any germinating seeds sprayed at regular intervals. If this is done before the young plants are more than eight to ten inches high they may be killed with two pounds of 2,4,5-T ester diluted in eighty gallons of water.



Ellington Curse (Acacia farnesiana). a part of stem showing leaves and thorns x 1; b stems and pods x 1; c bipinnate leaves x 2; d flower x 1.

BOTANY . . .

SEVENTH INTERNATIONAL GRASSLANDS CONGRESS

The 7th International Grasslands Congress was held at the Massey Agricultural College, Palmerston North, New Zealand, between November 7th and 15th, 1956. Fiji was represented at the Congress by Mr. N. Lamont, Deputy Director of Agriculture and Mr. J. W. Parham, Assistant Botanist, both these officers being on leave in New Zealand at the time.

The Grasslands Congress is held every four years when representatives from all interested countries gather together for discussions connected with grasslands. Inevitably, most of the representatives are from temperate climate countries and the majority of the papers presented are concerned with the grassland problems of these countries. At the 7th Congress fifty-two papers were presented of which two were directly concerned with the humid tropics. These two papers were "Some Fundamental Aspects of Grassland Agriculture in the Tropical Humid Lowlands of Hawaii", by M. Takahashi and "Grazing Management and Production of Some Tropical Grasses in the British West Indies", by M. S. Motta.

Probably the most important resolution passed at the Congress, from the point of view of the tropical countries, was one which recommended that there should be a tropical grasslands conference and that this should be held every four years, between International Congresses. F.A.O. was requested to investigate the possibilities of organizing such a conference of tropical workers.

The next International Grasslands Congress will be held in England in 1960.

New Agricultural Publication . . .

THE GRASSES OF FIJI

by J. W. PARHAM, B.Sc.

A Bulletin describing the grasses so far recorded in Fiji has been published and is now on sale at the Department of Agriculture.

The Bulletin contains botanical and general descriptions of the grasses of the Colony together with notes on the distribution and usefulness of each grass. There are sixty-one line drawings and twelve photographs. The book comprises 176 pages and is priced at 5s. per copy.

NAVUA SEDGE

It should be noted that the botanical name given for this weed in the article in the last issue of the Agricultural Journal (Volume 27, Nos. 3 and 4, December, 1956) is incorrect.

Specimens of Navua sedge have been identified by Dr. S. T. Blake of the Botanic Museum and Herbarium, Brisbane as—*Cyperus melanospermus* (Nees) Valck. Suring.

PRINCIPAL AGRICULTURAL AND LIVESTOCK PRODUCTS IMPORTED DURING 1956

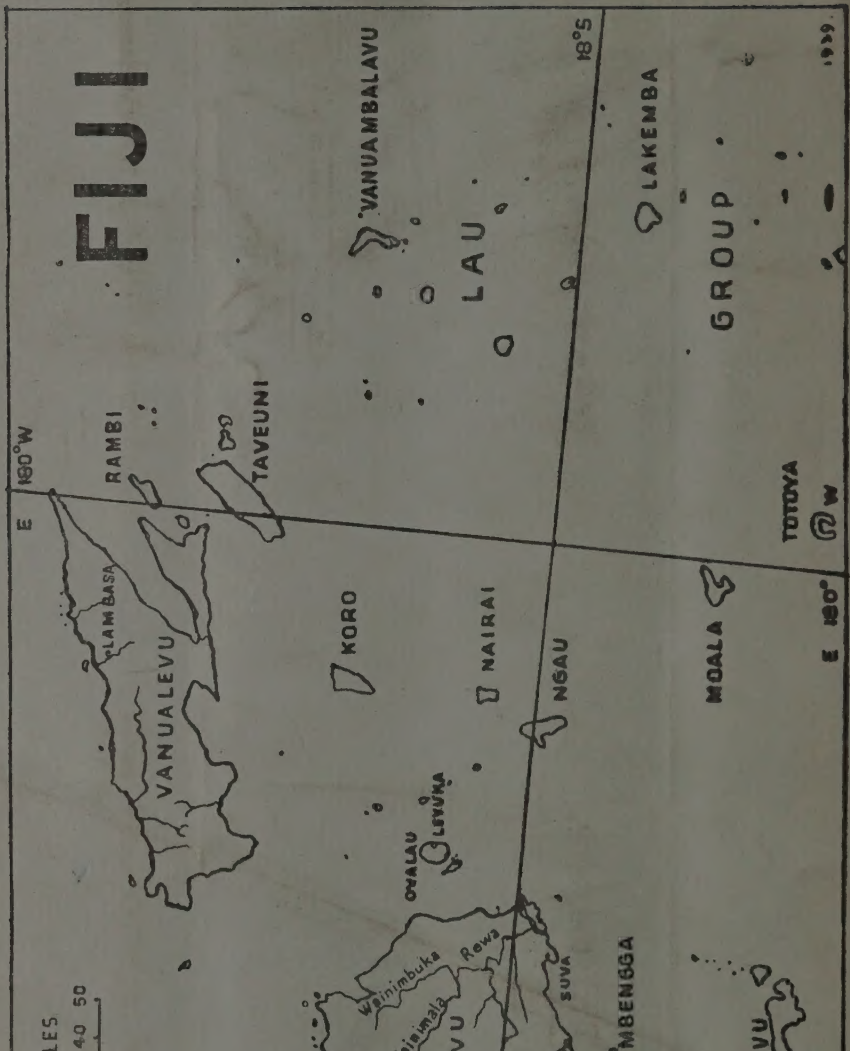
(Expressed in c.i.f. Values)

Commodity		Quantity	United Kingdom	Australia	New Zealand	Canada	U.S.A.	Other Countries	Total
			£F	£F	£F	£F	£F	£F	£F
Beef, Fresh, Canned, Dried and Salted	lb.	2,989,614	1,015	18,563	337,105	....	979	3,746	361,399
Butter and Substitutes ..	lb.	466,916	7,677	9,375	47,707	....	....	....	64,759
Ghee and Substitutes ..	lb.	1,329,237	....	1,191	170,856	....	....	1,171	173,218
Edible Oils	gal.	193,827	5,234	122	....	....	....	134,524	139,880
Poultry and Game	lb.	161,879	208	3,153	24,243	....	....	468	28,072
Fish, Fresh, Canned, Dried and Salted	lb.	3,193,075	46,439	1,050	8,133	31,669	83	172,298	259,672
Milk, Condensed, Dried and Evaporated	lb.	1,859,643	293	112,071	80,165	....	....	304	192,833
Potatoes	tons	2,837	3,296	13,130	136,586	....	17,547	16,542	187,101
Garlic	tons	196	....	12,003	8,123	....	....	8,726	28,852
Onions	tons	1,465	....	6,374	73,235	....	....	....	79,609
Rice	tons	2,990	....	43,278	121	....	....	177,666	221,065
Spices	lb.	703,177	218	6,822	192	....	85	44,255	51,572
Pulses	tons	1,785	....	22,715	18,250	....	....	80,713	121,678
Coffee	lb.	59,131	2,685	13,559	1,207	....	1,206	5,329	23,986
Eggs	doz.	37,387	....	3,389	7,872	....	....	71	11,332
Cheese	lb.	103,398	226	2,219	11,288	....	....	1,016	14,749
Honey	lb.	11,680	29	460	849	....	....	....	1,338
Maize	lb.	160,408	....	2,417	692	....	....	....	3,109
Total ..	..	....	67,320	271,891	926,624	31,669	19,891	646,829	1,964,224

PRINCIPAL AGRICULTURAL AND LIVESTOCK PRODUCTS EXPORTED IN 1956

(Expressed in f.o.b. Values)

Commodity		Quantity	United Kingdom	Australia	New Zealand	Canada	U.S.A.	Other Countries and Ships' Stores	Total
			£F	£F	£F	£F	£F	£F	£F
Bananas	cases	242,154	....	....	213,743	....	....	39	213,782
Copra	tons	4,066	266,868	....	....	....	....	....	266,868
Coconut Oil	tons	22,709	2,160,774	....	....	....	....	....	2,160,774
Coconut Meal	tons	9,675	....	....	38,924	27,202	30,943	77,301	174,369
Coconuts	No.	6,138	....	....	3	....	....	91	94
Sugar, Raw	tons	130,091	1,492,062	....	1,385,933	2,031,063	....	102,211	8,011,269
Molasses	tons	19,524	....	19,524	....	....	....	....	19,524
Rice Bran	tons	879	....	....	7,551	....	....	....	7,551
Peanuts	lb.	18,584	....	....	344	....	....	1,795	2,139
Hides	No.	10,377	....	10,282	5,810	....	....	....	16,092
Melons	lb.	34,257	....	....	937	....	....	....	937
Fruit, Miscellaneous ..	lb.	102,362	....	....	893	....	....	1,546	2,439
Pineapple, Canned	lb.	817,787	....	5,843	40,051	....	....	3,741	49,635
Fruit Juice and Syrups ..	lb.	199,965	....	3,558	1,898	....	....	449	5,905
Vegetables, Miscellaneous ..	lb.	282,235	....	29	3,434	....	....	4,899	7,352
Trocus Shell	tons	245	11,715	4,652	76	....	....	75,376	91,819
Crude Rubber	lb.	6,000	200	....	....	....	....	....	200
Total ..		....	3,931,619	43,888	1,699,597	2,058,265	30,942	267,438	8,031,749



So as to include Kadavu and Totoya within the framework available the map has been rotated some 6° to the east.